RUNNING HEAD: Multisensory integration processes in self-other merging

Synchronous Multisensory Stimulation Blurs Self-Other Boundaries

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Abstract

Bringing together recent work on body perception from cognitive neuroscience and social psychological research on social relations, we tested the hypothesis that a synchronous multisensory stimulation leads to self-other merging. We brushed the cheek of participants while they watched a stranger being brushed in the same way either in synchrony or asynchrony. This multisensory procedure had an effect both on body and social perception. Compared to asynchronous stimulation, synchronous stimulation led to more self-other merging in terms of body sensations and face resemblance, and also to self-other merging in terms of inner states, closeness and conformity behavior. The present research shows how multisensory integration can affect social perception and create a sense of self-other similarity.

Keywords: self-other merging; multisensory integration processes; social relations; rubber hand illusion

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Relations to beloved ones often describe a blurring of self-other boundaries: *you are part of me*, and *we are one*. Research shows that such merging can indeed occur at two levels: the conceptual and the bodily level. In the present work, we investigate whether factors that blur boundaries on the bodily level can also blur boundaries on the conceptual level.

Social psychological work has shown that in close relationships, others become cognitively confounded and merged with the self (Aron, Aron, & Norman, 2001). For example, in speeded classification tasks, personality characteristics of partners, friends (Aron, Aron, Tudor, & Nelson, 1991) and ingroup members (Smith & Henry, 1996) are confused with one's own characteristics. When asked to depict these relationships, drawings are chosen in which self and other are represented graphically as two close or overlapping circles (Inclusion of the Other in the Self scale, IOS; Aron, Aron, & Smollan, 1992; Schubert & Otten, 2002). Self-other merging also results from perspective taking (Davis, Conklin, Smith, & Luce, 1996, Galinsky & Moskowitz, 2000) and social identification (Cadinu & Rothbart, 1996; Goldstein & Cialdini, 2007).

Recent work in cognitive neuroscience has reported a different form of merging: that of bodily representations. The cognitive representation of one's own body is somehow flexible, as it is continuously updated based on multisensory inputs. Neurologically healthy individuals can include extracorporeal body-parts in their own body boundaries (Blanke & Metzinger, 2009; Makin, Holmes, Ehrsson, 2008). This is the case in the rubber hand illusion, in which watching a prosthetic rubber hand being brushed in synchrony with one's own concealed hand causes the feeling of the rubber hand becoming a part of one's own body (compared to asynchronous brushing, Botvinick & Cohen, 1998; Tsakiris & Haggard, 2005). The same can happen for other parts of the body. In Tsakiris' (2008) study, for instance, participants were touched on their cheek while they were looking at a face being touched synchronously or asynchronously. The face was a composite of their own and a stranger's face. After synchronous visual-tactile stimulation, participants tended to

see more of themselves in the composite face than after asynchronous stimulations: The representation of the own face became merged with the face of another person.

Does bodily self-other merging induced by synchronous multisensory inputs extend beyond body perception to the conceptual merging of self and other? The self is generally experienced as localized within the borders of the body (Baumeister, 1999; deVignemont, 2007). Furthermore, feedback from one's body directly influences one's self concept (Schubert & Koole, 2009). We argue that experiencing blurred boundaries of body representations could also blur boundaries of conceptual representations. As the representation of the own body becomes overlapping with that of another's body, the conceptual representation (i.e. traits, inner states, etc.) of the self and the other might also merge to some extent. Thus, the effect of this purely bodily manipulation could be equivalent to more conceptual manipulations that cause assimilation of self and other (Mussweiler, 2003).

To test this hypothesis, we brushed the cheek of healthy participants in synchrony (vs. asynchrony) with brushing applied to the face of a stranger shown in a video. We investigated the effect of this multisensory stimulation on *body perception* (i.e., self-other merging in terms of body sensations and face resemblance), on *social perception* (i.e., self-other merging in terms of inner states, closeness, and attraction), and on *conformity behavior*. We predicted that participants would experience the illusion of bodily merging after synchronous stimulation, and perceive the self as more similar to, and conform more to, the synchronously stimulated other than to the asynchronously stimulated other. Finally, we tested whether the bodily illusion mediated the social-cognitive effects.

Method

Participants

Sixteen students (mean age: 22 years; 13 female) of the University of Trento participated in the experiment in exchange for course credits.

Materials

Two 3 min videos were used, each showing the face of a woman (hair not visible) being touched on the left cheek by a small paintbrush moved in a constant rhythm. A pre-test showed that the two actors were judged equally attractive.

Procedure

Similarly to Tsakiris' (2008) study, participants were stroked on their cheek with a paintbrush while watching the video. In two consecutive blocks, the video showed either the face of a stranger being stroked in exact spatio-temporal synchrony, or the face of another stranger being stroked asynchronously with respect to the touches felt by the participant. Order (synchrony or asynchrony first) and combination of synchrony and face were counterbalanced across participants. Each stimulation phase was followed by a questionnaire and a conformity task. At the end of the experimental session, participants rated themselves and both targets on a series of issues. Then participants were debriefed and thanked for their participation.

Dependent Variables

Body illusion. Participants rated their sense of *ownership* (e.g., "It felt as if my face was turning into the face in the video," 4 items), control over the stranger's face (*agency*; e.g., "Sometimes I had the impression that if I had moved my eyes, the eyes of the person in the video would have moved too," 3 items), and whether they confused the locations of the seen and the felt touches (*location*; "It seemed as if the touch I felt was caused by the paintbrush touching the face in the movie," 3 items; Longo, Schüür, Kammers, Tsakiris, & Haggard, 2008).

Pleasantness of the stimulation. Two items assessed the pleasantness of the experience. Responses to these and the body illusion items were given on a bipolar continuum of 100 mm (-50 mm = totally disagree, 50 mm = totally agree).

IOS. Participants rated their relation toward the other on a variant of the IOS scale (Schubert & Otten, 2002; see Figure 1C)

Attraction toward the other. Responses to two questions were averaged to form an index of attraction toward the other (1 = not at all; 7 = completely).

Physical resemblance. Participants rated how similar the target was to themselves regarding several facial features.[1] An index of resemblance of core facial features was obtained by averaging the responses on mouth, nose and eyes. Ratings of the remaining features (forehead, cheeks, chin, face shape) formed an index of resemblance on peripheral face regions. Finally, participants rated their general resemblance to the actor. All responses were given on a 7-point scale (1 = not at all; 7 = completely).

Conformity task. An estimation task served as a subtle measure of conformity (Castelli, Vanzetto, Sherman, & Arcuri, 2001; Vaes, Paladino, Castelli, Leyens & Giovanazzi, 2003). A series of letters “a” appeared on the computer screen and participants estimated the number of letters displayed. At the top of the screen, the estimate given by the person they just watched in the video appeared. In each of the 14 trials, there were 200 letters “a”, but they were differently distributed on the screen, giving the impression of variation from trial to trial. The estimates supposedly provided by the person in the video varied as well, their average again being 200. Conformity was operationalized as the averaged absolute differences between the participant’s estimate and the anchors that were provided by the person in the video.

Inferences on inner states. After both stimulation blocks, an inference task was presented (Mitchell, Macrae, & Banaji, 2006). Seventeen questions on personality were presented three times: referring to self, referring to the synchronously stimulated target, and referring to the asynchronously stimulated target. The 51 questions were presented in random order. Within-participant correlations were calculated between the ratings of the self and the ratings of the synchronous target, and between the ratings of the self and the ratings of the asynchronous target. The *z*-transformed correlations formed an indirect index of self-other merging.

Results

The results displayed in Figure 1A show that synchronous stimulation led to enhanced illusions of bodily merging in all three facets, compared to asynchrony. First, feelings of ownership for the face in the video were higher after synchronous (M = -17.19, SD = 20.35, α = .85) than asynchronous stimulation (M = -27.36, SD = 21.13, α = .89), $F(1, 15) = 4.55$, $p = .050$, $\eta_p^2 = .23$. Second, confusion of locations of seen and the felt touches was higher after synchronous (M = -11.31, SD = 20.52, α = .77) than asynchronous stimulation (M = -32.15, SD = 22.86, α = .87), $F(1,15) = 12.57$, $p = .003$, $\eta_p^2 = .46$. Third, synchrony led to more feelings of control/agency over the face in the video (M = -8.15, SD = 18.91, α = .58) than asynchrony (M = -21.17, SD = 20.81, α = .67), $F(1,15) = 6.86$, $p = .019$, $\eta_p^2 = .31$. The synchronous stimulation was also perceived as being more positive (M = 20.72, SD = 17.02, α = .86) than the asynchronous stimulation (M = 9.44, SD = 26.33, α = .92), $F(1,15) = 4.70$, $p = .047$, $\eta_p^2 = .24$.

Continuing on *body perception*, we found that participants judged themselves as resembling more the synchronously (M = 2.94, SD = .93) than the asynchronously stimulated other (M = 2.38, SD = 1.20; Figure 1B), $F(1, 15) = 4.77$, $p = .045$, $\eta_p^2 = .24$. Specifically, resemblance regarding peripheral features of the face was higher after synchronous stimulation (M = 3.30, SD = .99, α = .74) than asynchronous stimulation (M = 2.78, SD = .98, α = .82), $F(1, 15) = 4.66$, $p = .047$, $\eta_p^2 = .24$. There was no effect on perceived resemblance of core features of the face, $F < 1$ ($\alpha_{syncronous} = .45$ and $\alpha_{asynchronous} = .47$). Presumably, peripheral regions, being less explored (Mertens, Siegmund, & Grusser, 1993) and more vaguely retained, were more readily replaced.

For *social perception*, we found that participants indicated more overlap on the IOS to the synchronously stimulated stranger (M = 2.88, SD = 1.46) than to the asynchronously stimulated stranger (M = 2.06, SD = .85), $F(1, 15) = 9.64$, $p = .007$, $\eta_p^2 = .39$, Figure 1C). As shown in Figure 1D, only the within participants correlation of self descriptions and other descriptions in the synchronous condition was positive and significantly different from zero (M = .43, SD = .55), *t(15)*

= 3.17, p = .006, showing that judgements of the synchronously, but not the asynchronously (M = .08, SD = .36) stimulated other were anchored in self knowledge. The difference between the self-other correlations in the two stimulation conditions was marginal, $F(1, 15) = 3.70$, $p = .074$, $\eta_p^2 = .20$.

The manipulation influenced the *affective reactions* toward the target (Figure 1E). Participants were more attracted toward the synchronously stimulated target (M = 4.41, SD = 0.82, α = .73) than the asynchronously stimulated target (M = 3.66, SD = 1.19, α = .90), $F(1, 15) = 5.19$, $p = .038$, $\eta_p^2 = .26$.

Finally, the analysis of *conformity behaviour* (Figure 1F) revealed that participants' estimates differed less from the estimates provided by the synchronously stimulated target (M = 50.69, SD = 33.73) than from those provided by the asynchronously stimulated target (M = 59.83, SD = 34.58), $F(1, 15) = 6.26$, $p = 0.024$, $\eta_p^2 = .29$.

A mediation analyses for within subject designs tested whether the experienced body illusion was responsible for the effects on the other variables. We averaged feelings of ownership and agency because the effects on these variables (i.e., the differences between conditions) were correlated with each other, but not with the effect on location. We ran separate analyses with this combined score and the location variable. Mediation was tested by computing the difference between synchronous and asynchronous conditions, and regressing this difference on both the sum of the tested predictor in the two conditions, and its difference between the two conditions (Judd, Kenny & McClelland, 2001). Mediation is indicated by a significant prediction by the difference; full mediation is shown when the estimated intercept is no longer significant (assuming that the sum variable was centered). As shown in Table 1, averaged ownership and agency feelings completely mediated the effects on general self-other resemblance, overlap, and conformity, but not on inference of the other's personality nor attraction. No mediation effect emerged for location.

Discussion

Synchronous multisensory experiences can influence what is included in the body representation (Blanke & Metzinger, 2009; Tsakiris, 2008). We show, for the first time, that multisensory integration processes can also have effects on social cognition and behavior. After a stranger was observed receiving a synchronous stimulation, she was seen as closer and more similar to the self, elicited more positive affective reactions, and had greater social influence. It seems that both projecting the self to the other (as in the inference task), and anchoring one's behaviour in that of other (as in the conformity task) took place. Synchronous multisensory stimulation blurred self-other conceptual boundaries even when the perceived other was a total stranger.

In our sample of healthy adults, this phenomenon was subtle. It emerged as a relative difference between synchronous and asynchronous conditions, rather than taking the form of a delusional belief that disregarded the obvious discrepancies between the observer and the stranger in terms of facial features and location in space.

The body illusion mediated most but not all the social-cognitive outcomes. Presumably, the affected variables are better proxies of the sense of self-other similarity. The unmediated effects on attractiveness of others and inferences on their traits are both likely to be influenced also by other factors rather than similarity (e.g. the specific aspect to infer).

The current study shows that the cognitive phenomenon of self-other overlap, which is typically experienced with close others and ingroup members, can arise from a purely sensorial experience. This adds to findings showing that embodied processes may ground self-other overlap and social identification (Fiske, 2004; Gallace & Spence, 2008; Schubert, Waldzus, & Seibt, 2008).

Acting in synchrony is a common way to implement and communicate a communal relation that is characterized by the feeling of being all the same and united by a common identity (Fiske, 2004). Recent research (Wilthermuth & Heath, 2009) showed that acting in synchrony can foster group unity and cooperation. Our findings suggest that spatio-temporally correlated multisensorial

stimulations might be one of the processes that underlie the effects of synchronous behavior. When dancing or marching in synchrony, for example, one *feels* one's feet striking the ground, repeatedly and in close temporal synchrony with *seeing* other people's feet striking the ground. This adds to seeing how others conform to one’s own action plans (Wegner, Sparrow, & Winerman, 2004). As we showed, the integration of these multisensorial signals creates both overlapping bodily representations and self-other overlap in thought and behavior.

References

Aron, A., Aron E. N., & Norman, C. (2001). The self-expansion model of motivation and cognition in close relationships and beyond. In M. Clark & G. Fletcher (Eds.), *Blackwell handbook of social psychology*, Vol.2: Interpersonal processes (pp. 478-501). Oxford: Blackwell.

Aron, A., Aron, E.N., & Smollan, D. (1992). Inclusion of other in the self scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology, 63,* 596-612.

Aron, A., Aron, E. N., Tudor, M., & Nelson, G. (1991). Close relationships as including other in the self. *Journal of Personality and Social Psychology, 60,* 241-253.

Baumeister, R. F. (1999). The nature and the structure of the self: An overview. In R. F. Baumeister (Ed.), *The self in social psychology* (pp. 1-20). Philadelphia: Psychology Press.

Blanke, O., & Metzinger, T. (2009). Full-body illusions and minimal phenomenal selfhood. *Trends in Cognitive Sciences, 13*, 7-13.

Botvinick, M. & Cohen, J. D. (1998). Rubber hand ‘feels’ what eyes see. *Nature, 391*, 756.

Cadinu, M.R., & Rothbart, M. (1996). Self-anchoring and differentiation processes in the minimal group setting. *Journal of Personality and Social Psychology, 70,* 661-677.

Castelli, L., Vanzetto, K., Sherman, J., & Arcuri, L. (2001). The explicit and implicit perception of ingroup members who use stereotypes: Blatant rejection but subtle conformity. *Journal of Experimental Social Psychology, 37*, 419–426.

Davis, M.H., Conklin, L., Smith, A., & Luce, C. (1996). Effect of perspective taking on the cognitive representation of a person: a merging of self and other. *Journal of Personality and Social Psychology, 70*, 713-726.

De Vignemont, F. (2007). Habeas corpus: The sense of ownership of one's own body. *Mind & Language, 22*, 427-449.

Fiske, A.P. (2004). Four modes of constituting relationships: Consubstantial assimilation; space, magnitude, time, and force; concrete procedures; abstract symbolism. In: N. Haslam (Ed.),

Relational models theory: A contemporary overview (pp. 61–146). Mahwah, NJ: Lawrence Erlbaum Associates..

Galinsky, A.D., & Moskowitz, G.B. (2000). Perspective-taking: decreasing stereotype expression, stereotype accessibility, and in-group favouritism. *Journal of Personality and Social Psychology, 78,* 708-724.

Gallace, A., & Spence, C. (2008). The science of interpersonal touch: An overview. *Neuroscience and Biobehavioral Review,* doi:10.1016/j.neubiorev.2008.10.004.

Goldstein, N.J., & Cialdini, R.B. (2007). The spyglass effect: a model of vicarious self-perception. *Journal of Personality and Social Psychology, 92,* 402-417.

Judd, C. J., Kenny, D. A., & McClelland, G. H.(2001). Estimating and testing mediation and moderation in within-subject designs. *Psychological Methods, 6,* 115-134.

Longo, M. R., Schüür, F., Kammers, M. P. M., Tsakiris, M. & Haggard, P. (2008). What is embodiment? A psychometric approach. *Cognition, 107*, 978-998.

Makin, T. R., Holmes, N. P. & Ehrsson, H. H. (2008). On the other hand: Dummy hands and peripersonal space. *Behavioural Brain Research, 191,* 1–10.

Mertens, I., Siegmund, H., & Grüsser, O. J. (1993). Gaze motor asymmetries in the perception of faces during a memory task. *Neuropsychologia, 31*, 989-998.

Mitchell, J. P., Macrae, C. N., & Banaji, M. R. (2006). Dissociable medial prefrontal contributions to judgments of similar and dissimilar others. *Neuron, 50,* 655–63.

Mussweiler, T. (2003). Comparison processes in social judgment: Mechanisms and consequences. *Psychological Review, 110*, 472-489.

Schubert, T. W., & Koole, S. L. (2009). The embodied self: Making a fist enhances men's power-related self-conceptions. *Journal of Experimental Social Psychology*, *45*, 828 – 834.

Schubert, T., & Otten, S. (2002). Overlap of self, ingroup, and outgroup: Pictorial measures of self-categorization. *Self & Identity, 1*, 535-576.

Schubert, T., Waldzus, S., & Seibt, B. (2008). The embodiment of power and communalism in space and bodily contact. In G. R. Semin & E. R. Smith (Eds.), *Embodied Grounding: Social, Cognitive, Affective, And Neuroscientific Approaches.* (pp. 160-183). New York: Cambridge University Press.

Smith, E. R., Henry, S. (1996). An in-group becomes part of the self: Response time evidence. *Personality and Social Psychology Bulletin, 22,* 635-642.

Tsakiris, M. (2008). Looking for myself: Current multisensory input alters self-face recognition. *PlosOne, 3,* e4040.

Tsakiris, M., & Haggard, P. (2005). The rubber hand illusion revisited: visuotactile integration and self-attribution. *Journal of Experimental Psychology: Human Perception and Performance, 31,* 80-91.

Vaes, J., Paladino, M. P., Castelli, L., Leyens, J. Ph., Giovanazzi, A. (2003). On the behavioral consequences of infra-humanization: The implicit role of uniquely human emotions in intergroup relations. *Journal of Personality and Social Psychology, 85,* 1016-1034.

Wilthermuth S. S., Heath C. (2009) Synchrony and cooperation. *Psychological Science, 20,* 1-5.

Wegner, D. M., Sparrow, B., & Winerman, L. (2004). Vicarious agency: Experiencing control over the movements of others. *Journal of Personality and Social Psychology, 86, 838-848.*

Yzerbyt, V. Y., Schadron, G., Leyens, J.-Ph., & Rocher, S. (1994). Social judgeability: The impact of meta-informational cues on the use of stereotypes. *Journal of Personality and Social Psychology, 66,* 48-55.

Footnotes

[1] To increase participants' feeling of being entitled to judge, participants were told resemblance of faces can be quickly detected and that they received subliminal information on the target during the video (Yzerbyt, Schadron, Leyens, & Rocher, 1994). A copy of the questionnaire is available on request.

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Table 1

Mediation of effects of synchrony (vs. asynchrony) on resemblance judgments and social variables by averaged feelings of ownership and agency

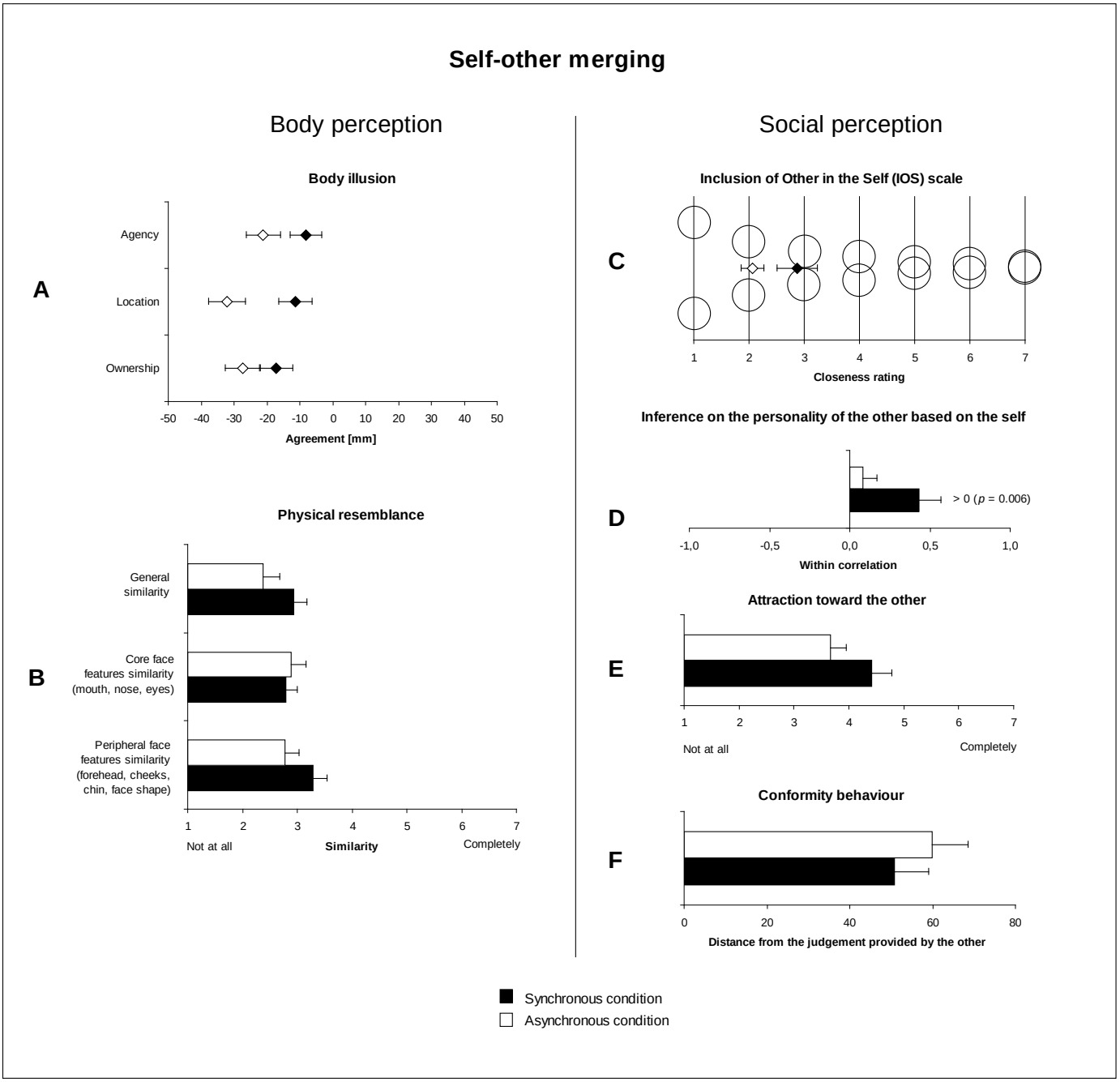
	Dependent variable Y in the model																							
	Physical resemblance								Social perception															
	General				Peripheral face feature				IOS				Inference task				Conformity task				Attraction			
Predictor	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*	*B*	*SE*	*T*	*p*	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*
d_0	0.17	0.27	0.64	.536	0.29	0.29	1.01	.331	0.45	0.29	1.53	.150	0.37	0.24	1.54	.148	4.02	3.97	1.01	.329	0.42	0.39	1.06	.311
X_S (d_1)	0.01	0.01	1.37	.194	0.01	0.01	0.77	.454	0.00	0.01	0.52	.615	0.00	0.01	0.11	.911	-0.07	0.11	-0.68	.509	0.01	0.01	0.71	.493
X_D (d_2)	0.04	0.01	2.60	.022	0.02	0.01	1.36	.197	0.03	0.02	2.19	.048	-0.01	0.01	-0.12	.906	0.45	0.20	2.26	.042	0.03	0.02	1.48	.162

Note. Following Judd, Kenny and McClelland (2001), mediation of effects of a within subjects factor on a dependent variable Y by a mediator X was tested with the equation $Y_D = d_0 + d_1X_S + d_2X_D$, where Y_D is the difference between the conditions in Y, X_S is the sum of X in both conditions, and X_D the difference between conditions in X. In all displayed regressions, the tested mediator X was the average of assessed feelings of ownership and agency.

Figure Captions

Figure 1. Self-other merging on body illusion, physical resemblance judgments, and social perception measures in the synchronous (black) and asynchronous (white) condition [mean ± 1 *SE*M (error bars)].

Figure 1


Self-other merging
Body perception
Social perception
A
Body illusion
Agency
Location
Ownership
-50 -40 -30 -20 -10 0 10 20 30 40 50
Agreement [mm]
B
Physical resemblance
General similarity
Core face features similarity (mouth, nose, eyes)
Peripheral face features similarity (forehead, cheeks, chin, face shape)
1 2 3 4 5 6 7
Not at all
Similarity
Completely
C
Inclusion of Other in the Self (IOS) scale
1 2 3 4 5 6 7
Closeness rating
D
Inference on the personality of the other based on the self
> 0 (p = 0.006)
-1,0 -0,5 0,0 0,5 1,0
Within correlation
E
Attraction toward the other
1 2 3 4 5 6 7
Not at all
Completely
F
Conformity behaviour
0 20 40 60 80
Distance from the judgement provided by the other
Synchronous condition
Asynchronous condition